Landscape Ecosystems and Native Plant Communities

Where we've been and where we're going

Early efforts for the 1st NE Landscape Plan

Report	Author	Date
Range of Natural Variability in Forest Structure for the NSU	Lee Frelich, UM, for FRC	Sept 1999
Native Plant Communities of the Northern Superior Uplands (Draft)	Kurt Rusterholst, DNR Natural Heritage Program	Nov 1999
Landscape Ecosystems for the NSU: Draft Map & Methods	Mark White &George Host, NRRI	Aug 2000
NSU 10 Year Growth Stages	Terry Brown & Mark White	2000
Northeast Landscape RNV Analysis	White, Brown, Host	Jan 2001
1990-2002 Trend Assessment	Brown & Host	2006

Premises

- Understanding how different forest ecosystems respond to past disturbance is a key to understanding how they'll behave in the future
- NSU contains communities that respond differently to disturbance
  - Northern Hardwoods
  - Red &White Pine
  - Aspen-birch-spruce-fir
  - Lowland Conifers

Landscape Ecosystems (Frelich)

- Identified late successional forest communities
  - Similar to but predates MN DNR Native Plant Community Classification
- Focus of Lee Frelich's forest disturbance history work
  - Tree ring
  - Air photo
  - Canopy gap assessment
- Understand role of fire and wind in structuring different forest communities
- Based on Vegetation Growth Stages (VGS)

Vegetation Growth Stage

- An integration of forest development and forest succesional stages

Developmental stages:

- stand age 0–10: initiation
- stand age 11–50: stem exclusion
- stand age 51–80: demographic transition
- stand age ≥81: multi-aged

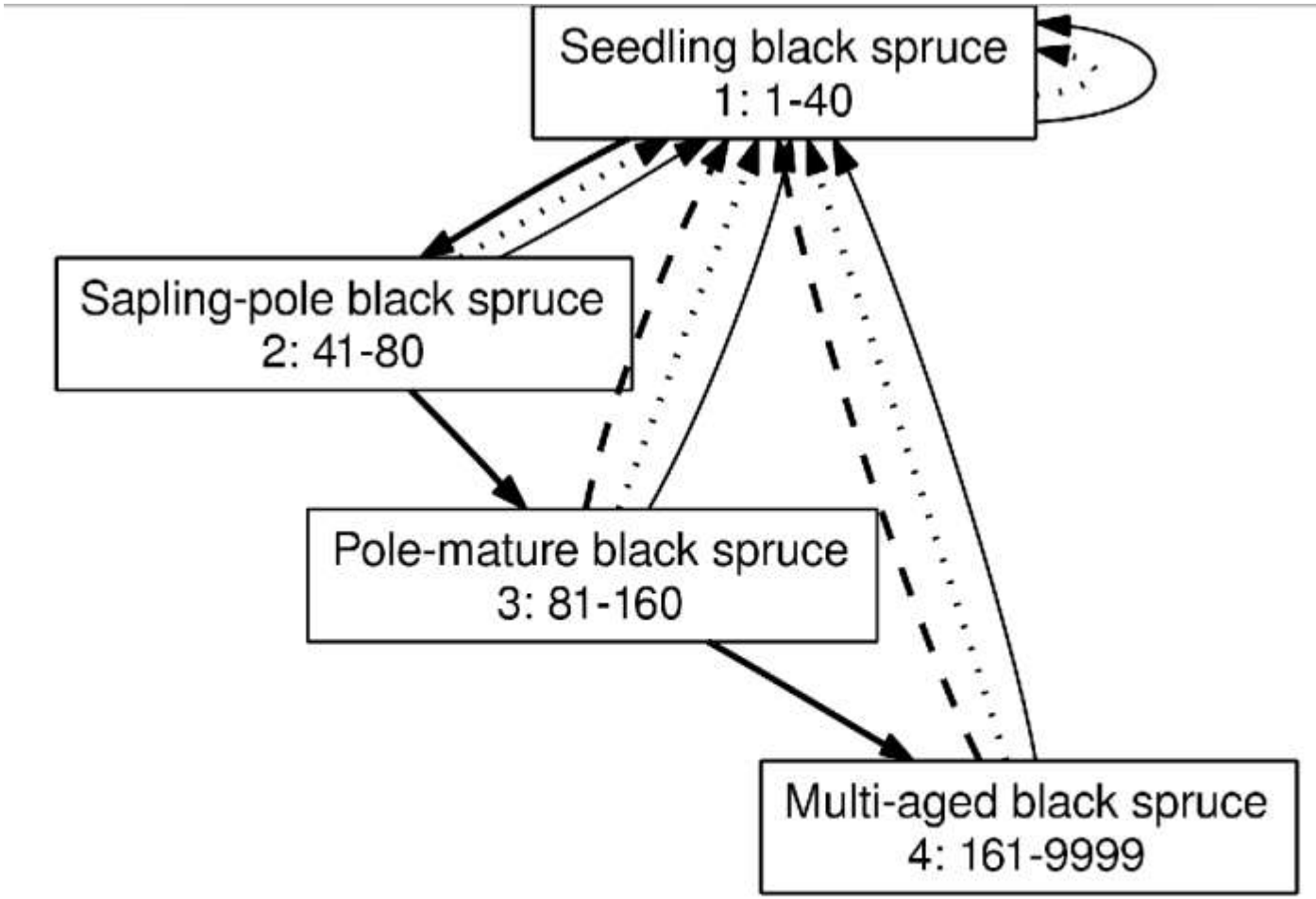
Successional stages:

- stand age 0–40: aspen
- stand age 41–80: aspen with fir understory
- stand age 81–100: mixed aspen and fir
- stand age ≥101: fir

Vegetation Growth Stage

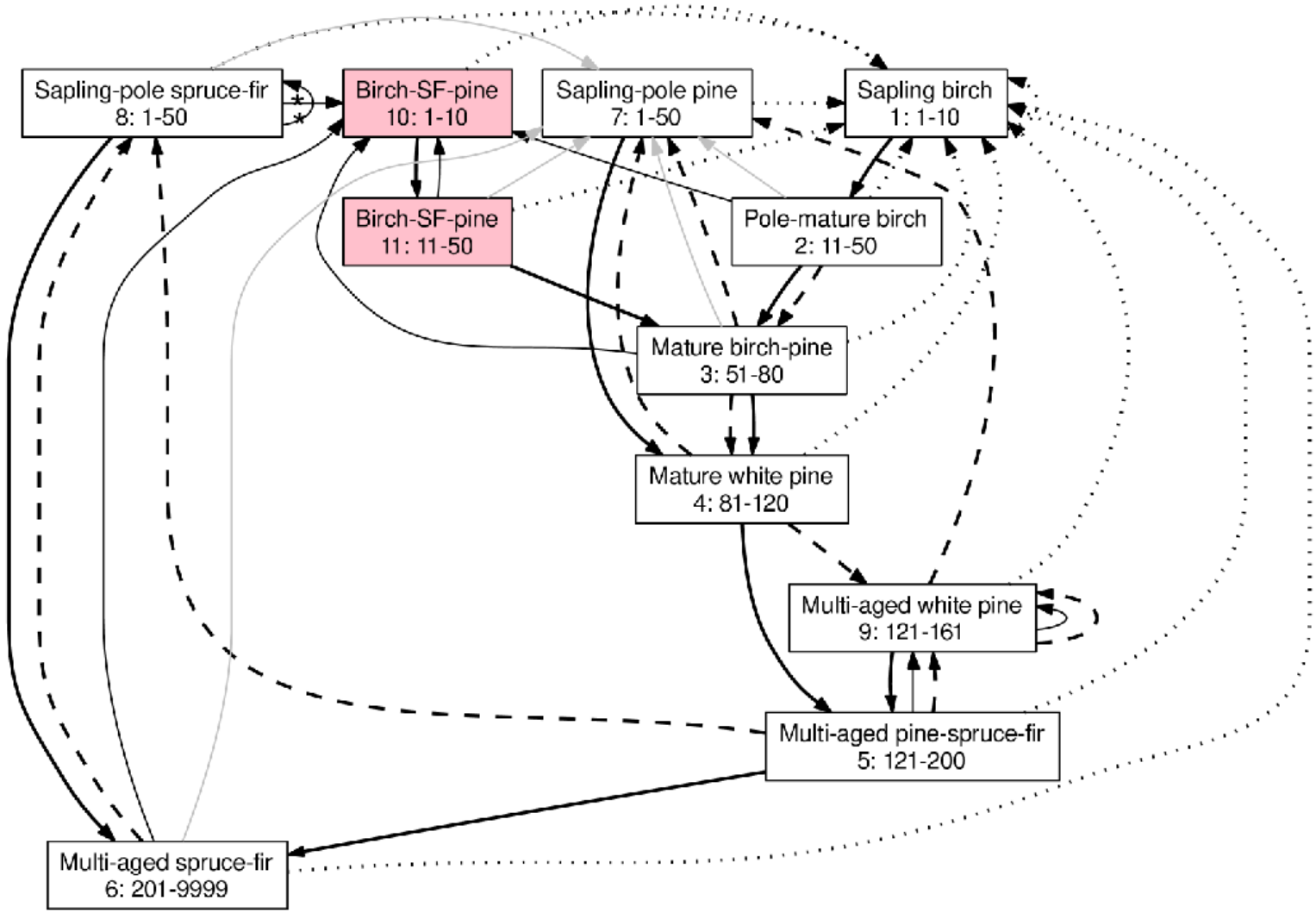
Vegetation growth stages:

- stand age 0–10: aspen-dominated initiation
- stand age 11–40: aspen-dominated stem exclusion
- stand age 41–50: aspen–fir stem exclusion
- stand age 51–80: aspen–fir demographic transition
- stand age 81–100: multi-aged aspen–fir
- stand age ≥101: multi-aged fir



NSU_4 Northern Superior Uplands Lowland Conifer

Simple succession — Stand replacing wind — Stand replacing fire — Clear cut type management



NSU_2 Northern Superior Uplands
Mesic white and red pine

Simple succession

Stand replacing wind

Stand replacing fire

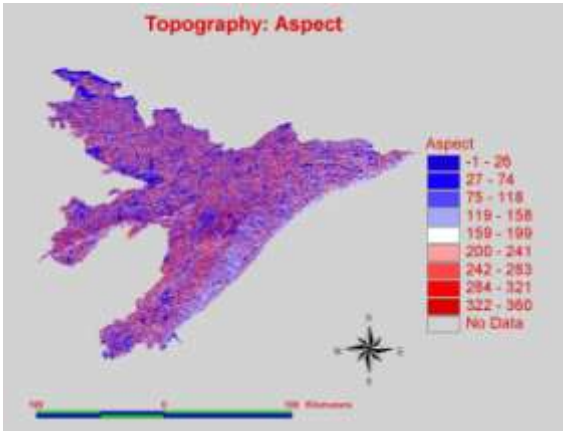
Clear cut type management

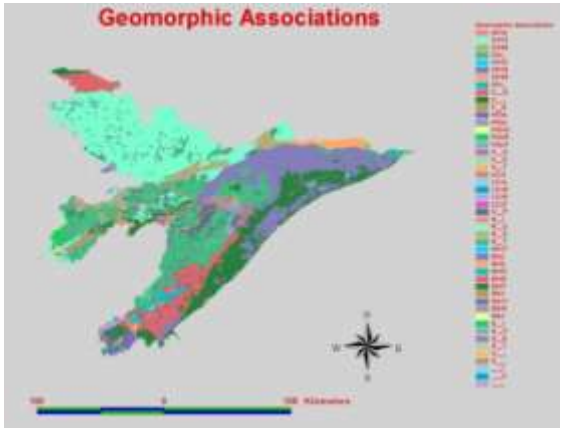
Use of VGS models

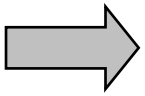
- Understanding stand development and forest succession by landscape ecosystem can guide forest management
  - Manage for best use of a particular site
- Combined with ownership, allows an assessment of ‘who owns what?”
- But - need a map…

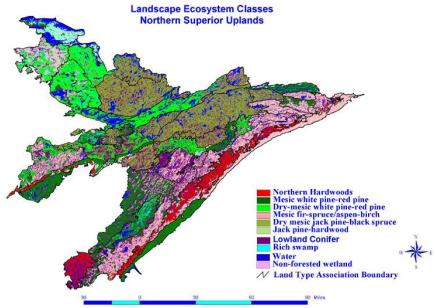
Mapping Landscape Ecosystem of the Northern Superior Uplands

- Approach: develop relationships between important GIS layers (soil, landform, climate) and forest inventory data
- Predict dominant late successional communities across the landscape







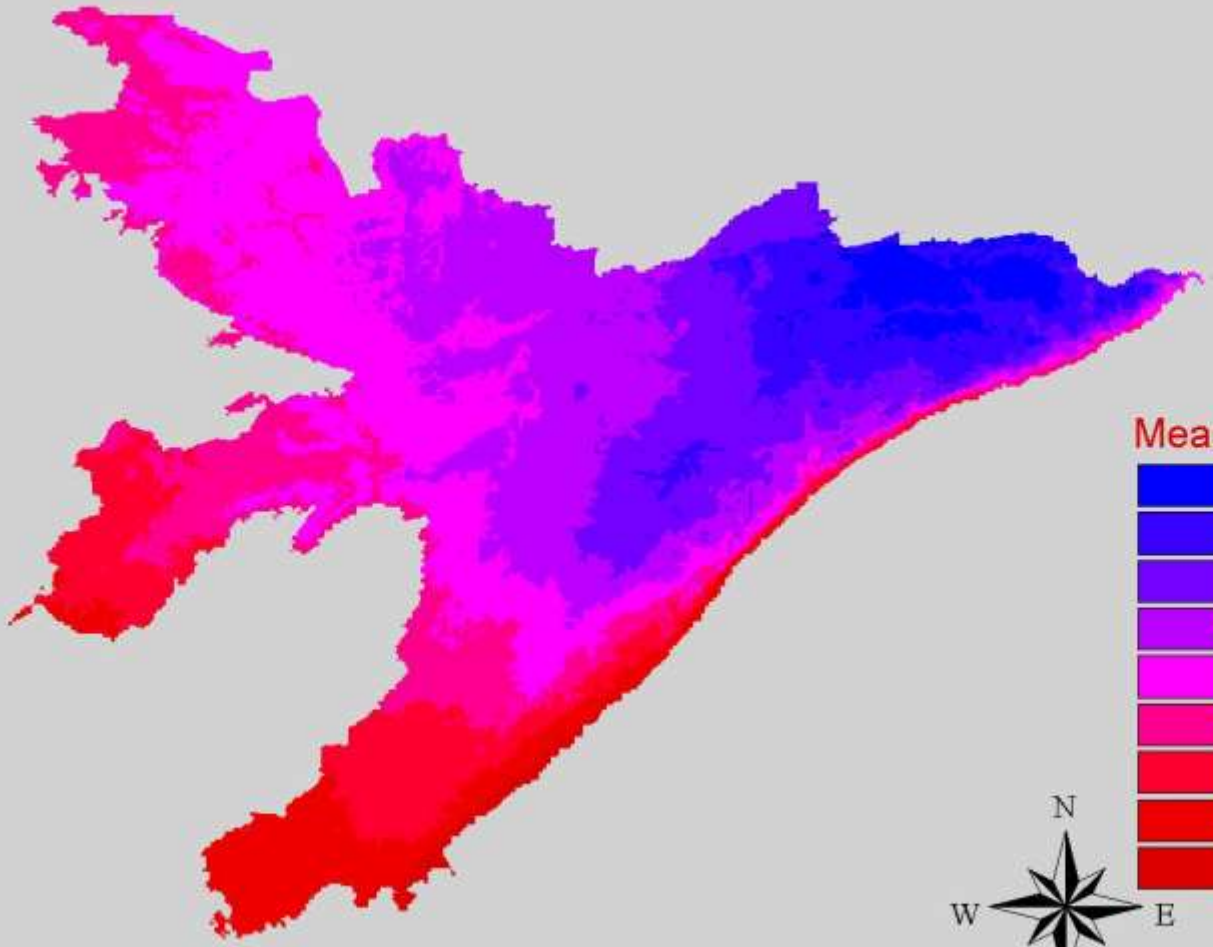


White and Host 2000

Environmental drivers influencing forest composition

Data Source	Attributes	Minimum mapping unit
Minnesota Soil Atlas	Drainage, Texture, pH Depth of rooting zone	16ha
Cummings-Grigal Soil Associations	Texture+material	$5km^2$
Geomorphology of MN	Geomorphic and sedimentary Associations	16ha
Land Type Associations	Soil-landform units	$5km^2$
Zedex Climate data	Mean growing season minimum, maximum temperature, Precipitation	$1km^2$
USGS digital elevation	elevation, slope, aspect,	1ha

Growing Season Maximum Temperature (F *10)



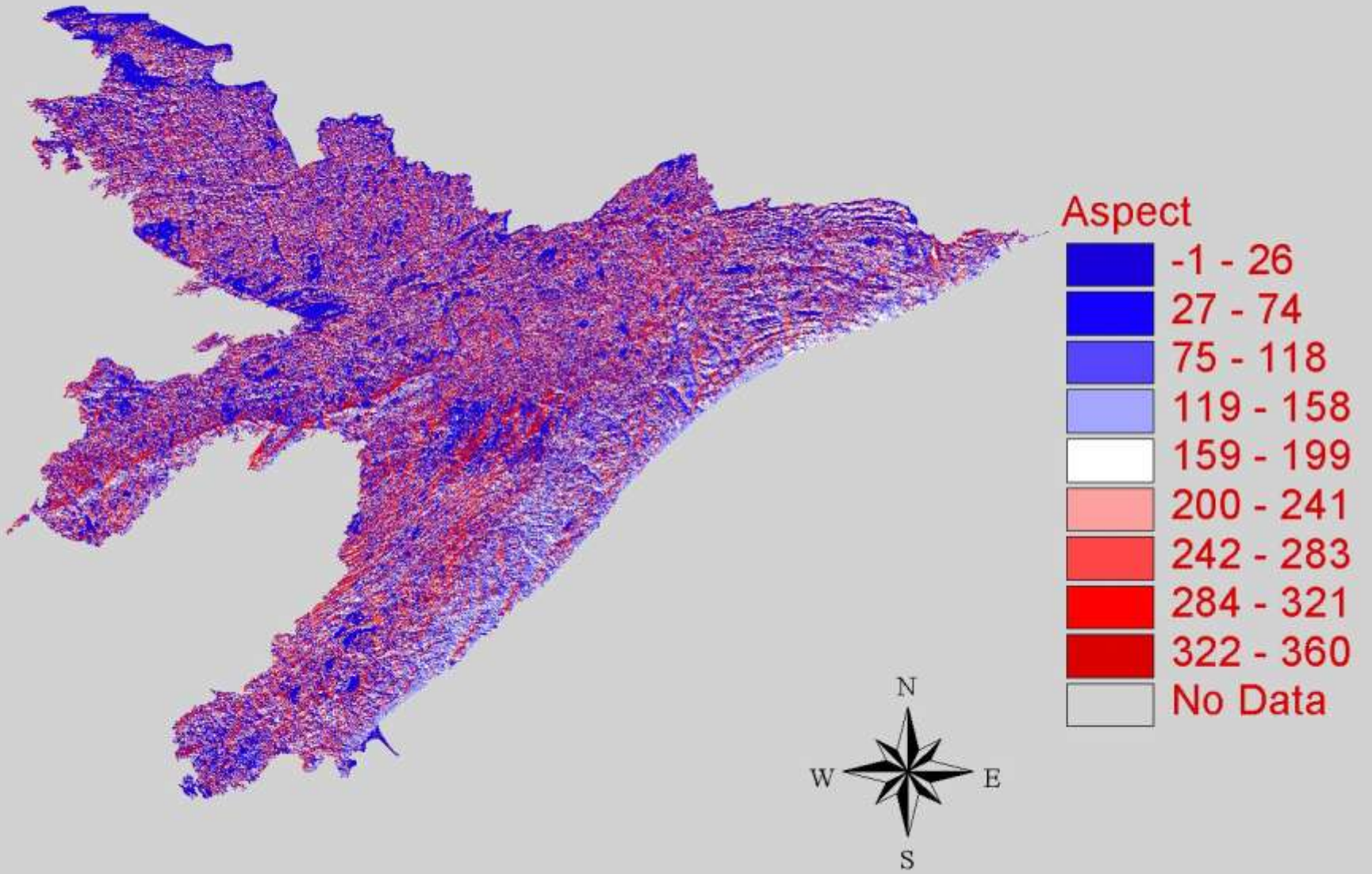
Mean Maximum Temperature

- 681 - 693
- 694 - 699
- 700 - 705
- 706 - 711
- 712 - 716
- 717 - 721
- 722 - 727
- 728 - 735
- 736 - 745

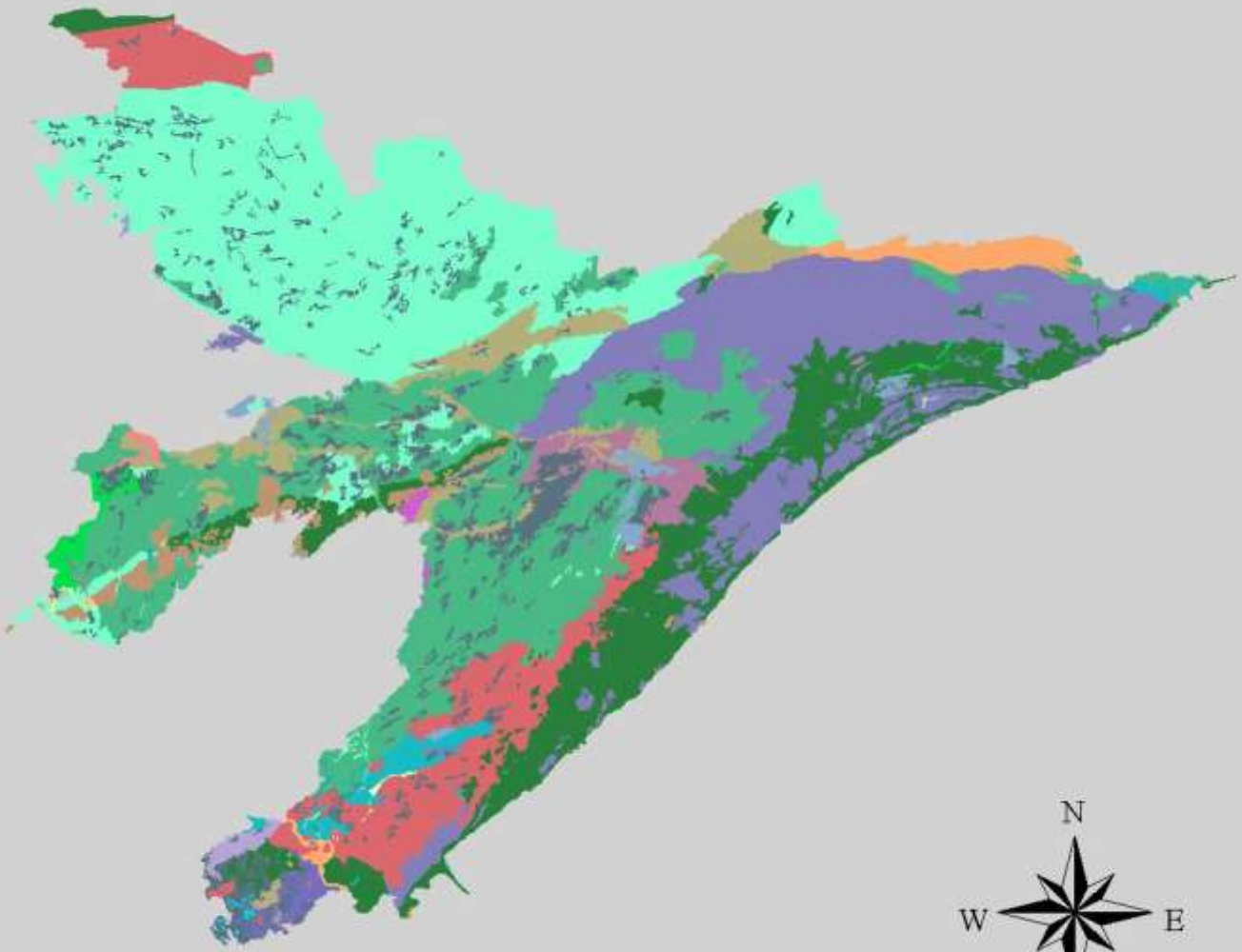
N
W
E
S

100 0 100 Kilometers

Topography: Aspect



Geomorphic Associations



Geomorphic Associations
AKoL
CArG
CArM
CAr_
CPrD
CPrG
CPrM
CPr_
C__G
C___
F__A
HDuL
KGuI
KGuO
KGuS
KGuT
K__O
K__S
K__T
LCuI
LCuL
LCuO
LCuS
LCuT
O__P
R__I
R__O
R__S
R__T
SAnT
SHiI
SHiL
SHiO
SHiS
SHiT
SSrI
SSrO
SSrS
SStI
S__I
S__O
S__S
S__T
U___
X___
___I
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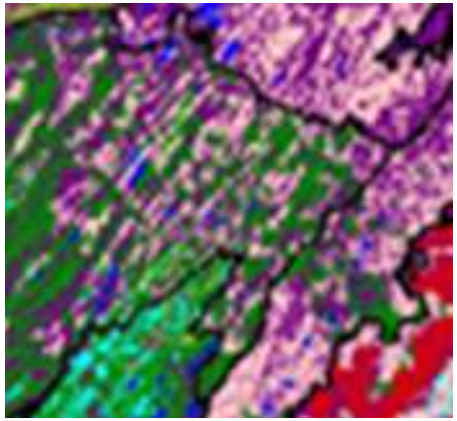
100 0 100 Kilometers

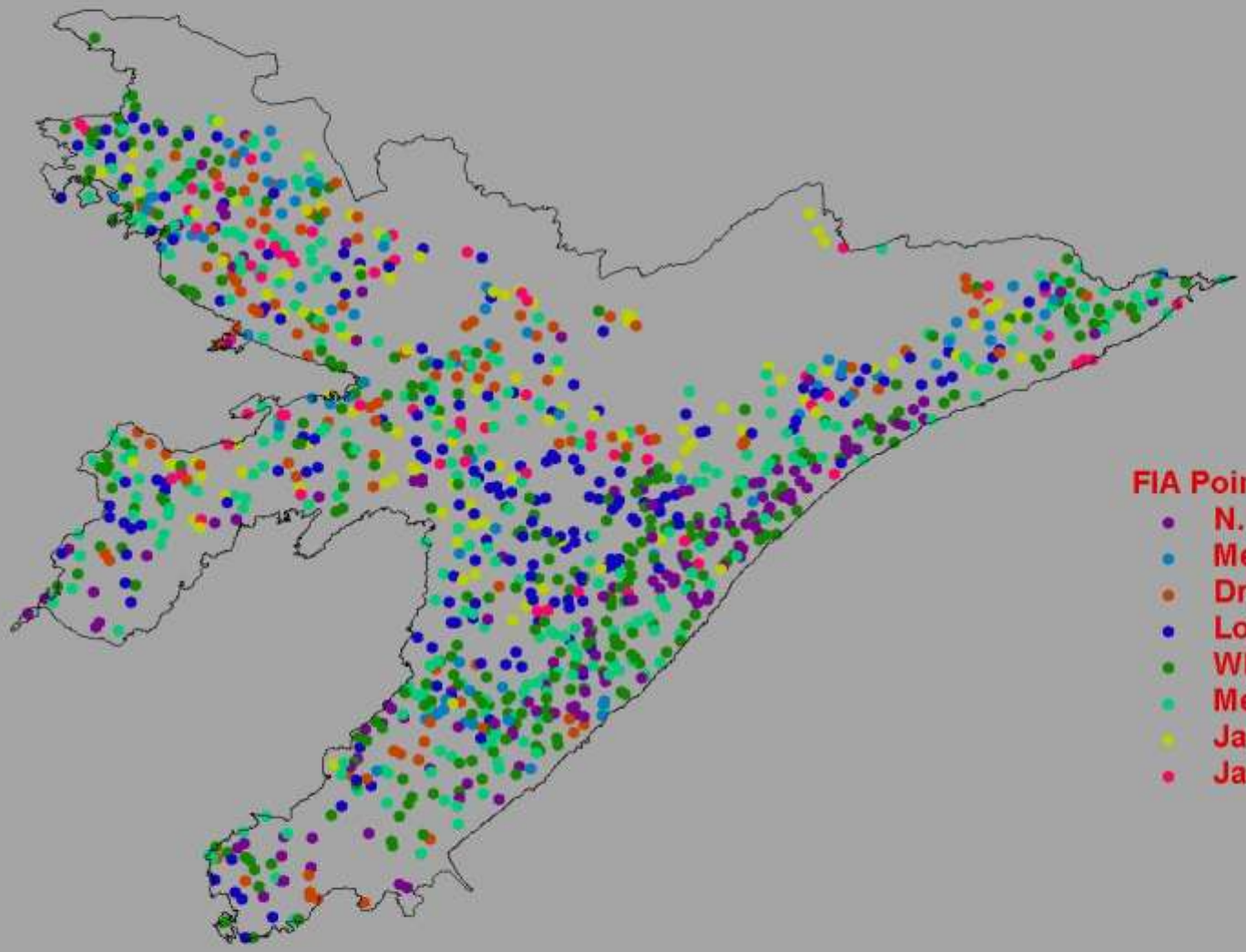
Spatial Modeling

1. Principal Component/Cluster Analysis to identify combinations of soil, landform & climate the recur in characteristic landscape positions
2. Identify statistical associations between landscape units and forest inventory plots



Forest Inventory Data Sources	Attributes Used To Classify Inventory into Landscape Ecosystems	Data Criteria	N
MN DNR Phase2 Inventory	Relative Volume by Species Cover type Shrub/ground layer data	Natural Regeneration Field Inventory Age >= 40	6400
FIA Remeasurement plots	Relative Basal Area by species Cover type	Natural Regeneration Field Inventory Age >= 40	1245
Superior National Forest Inventory	Primary-secondary cover type Primary-secondary species	Natural Regeneration Field Inventory Age >= 40	13900
Natural Heritage Program Releve plots	Native Plant Community classification	None	298
GLO Bearing Tree Database	Tree species	Section corners > 2 bearing trees	

Classified FIA Points (n = 1245)

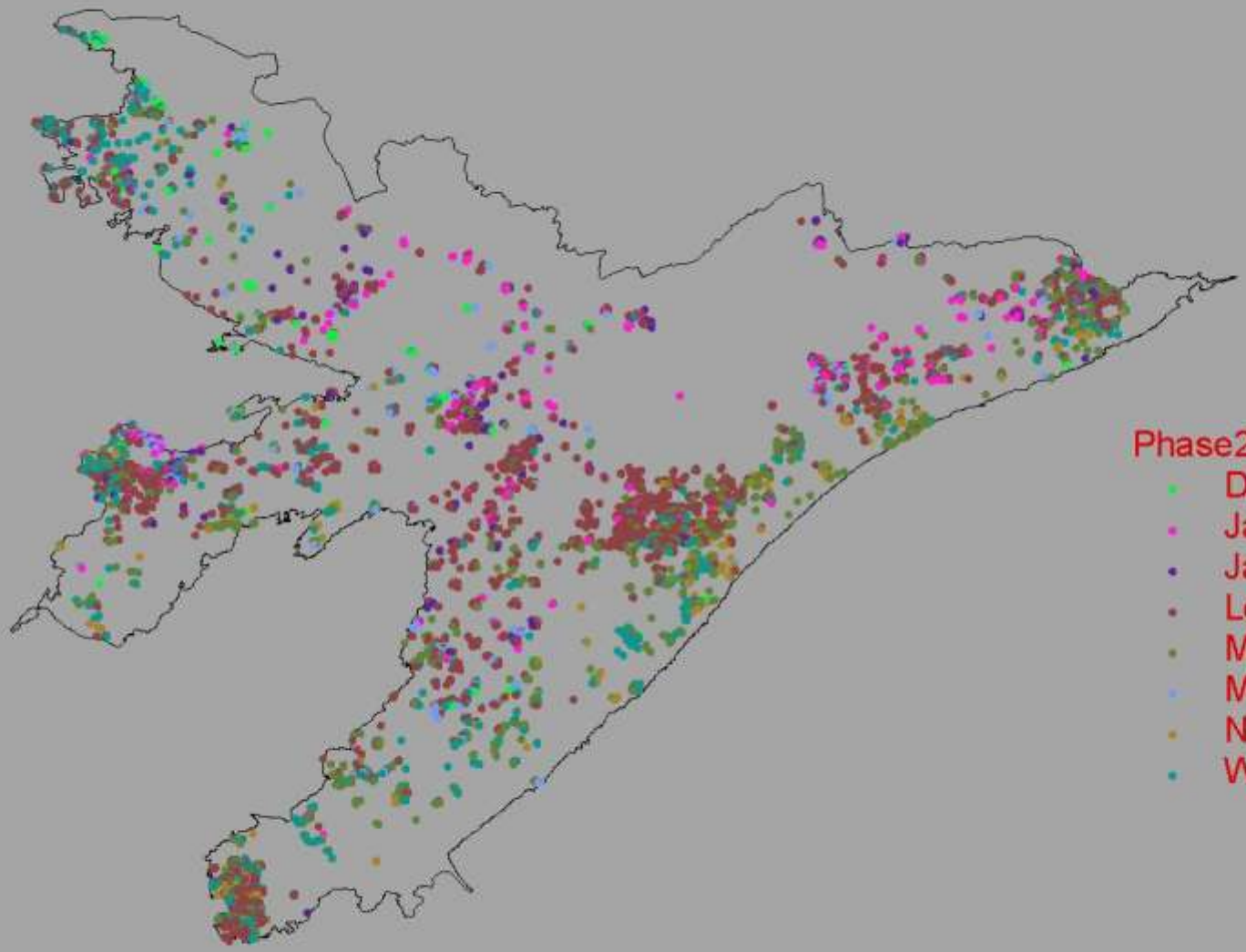


FIA Points
- N. hardwood
- Mesic Wp-RP
- Dry-,mesic Wp-Rp
- Lowland Conifer
- White cedar-black ash
- Mesic spruce-fir/hwd
- Jack pine-B. spruce
- Jack pine-hardwood

N
W E
S

100 0 100 Kilometers

Classified MN DNR Inventory (n = 6400)

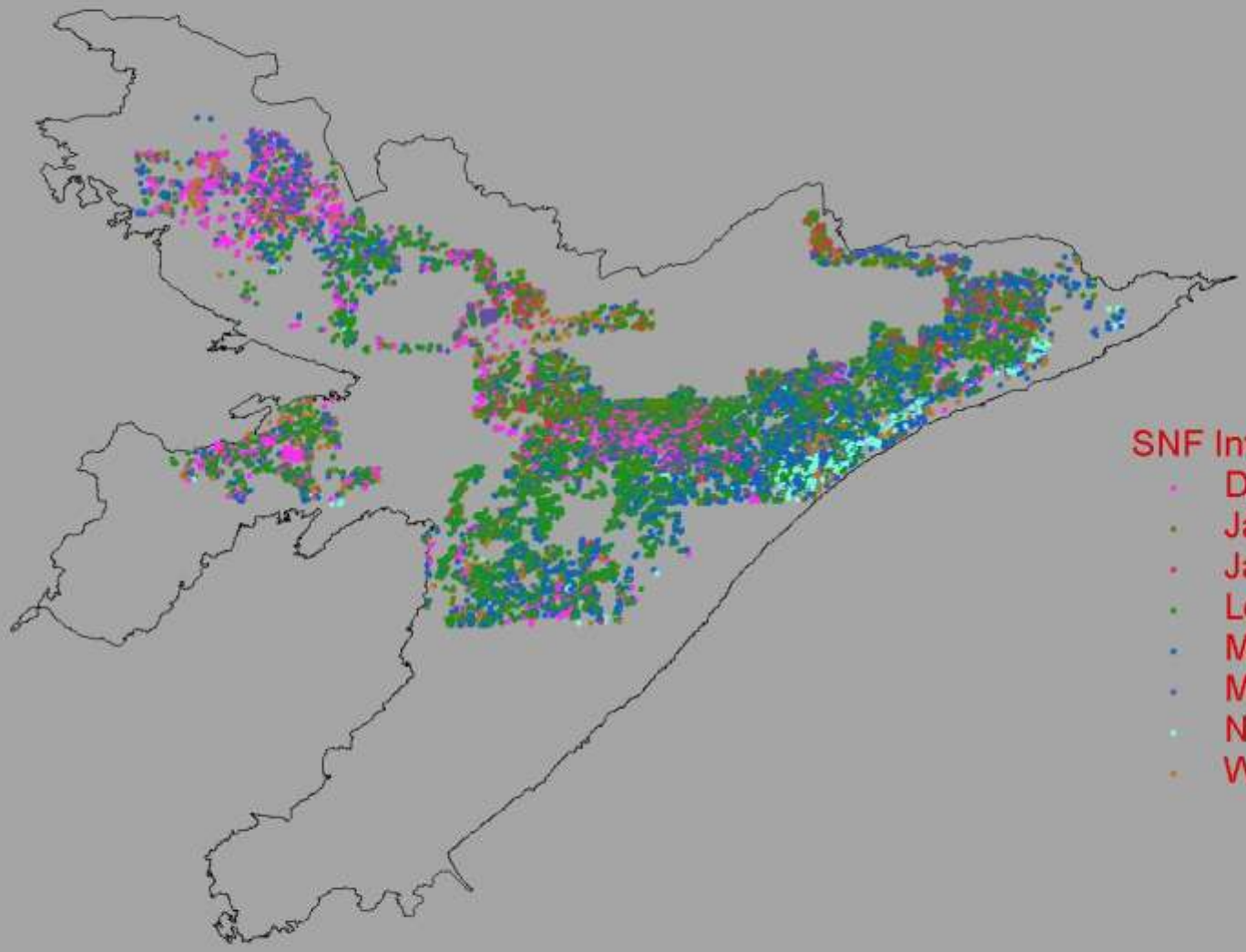


Phase2 Inventory
- Dry-mesic Wp-Rp
- Jack pine-black spruce
- Jack pine-hwd
- Lowland conifer
- Mesic Spruce-fir/hwd
- Mesic Wp-Rp
- Northern hardwood
- White Cedar-black ash

N
W E
S

100 0 100 Kilometers

Classified Superior National Forest Inventory (n = 13900)



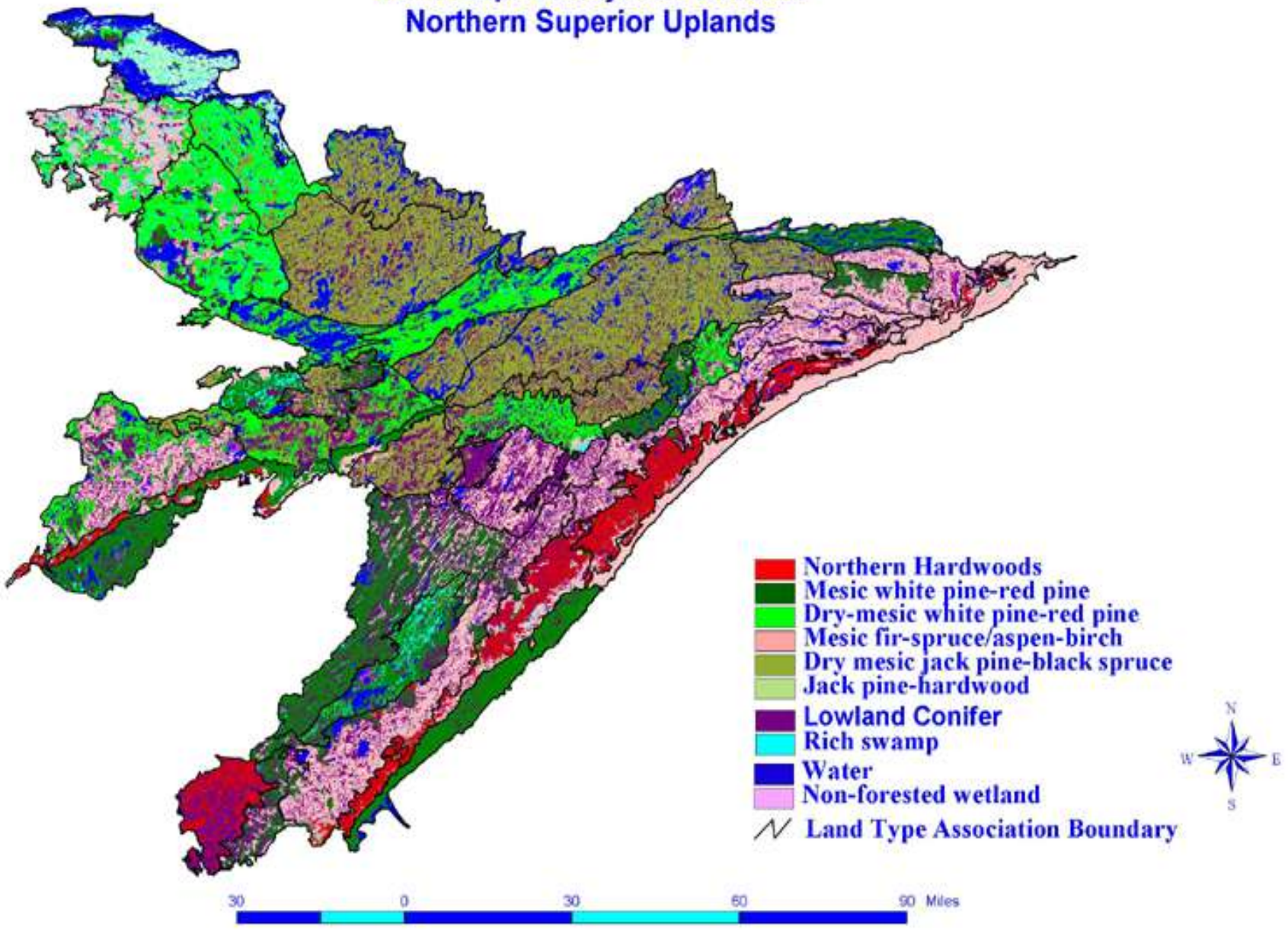
SNF Inventory
- Dry-mesic Wp-Rp
- Jack pine-black spruce
- Jack pine-hwd
- Lowland conifer
- Mesic Spruce-fir/hwd
- Mesic Wp-Rp
- Northern hardwood
- White Cedar-black ash

N
W E
S

100 0 100 Kilometers

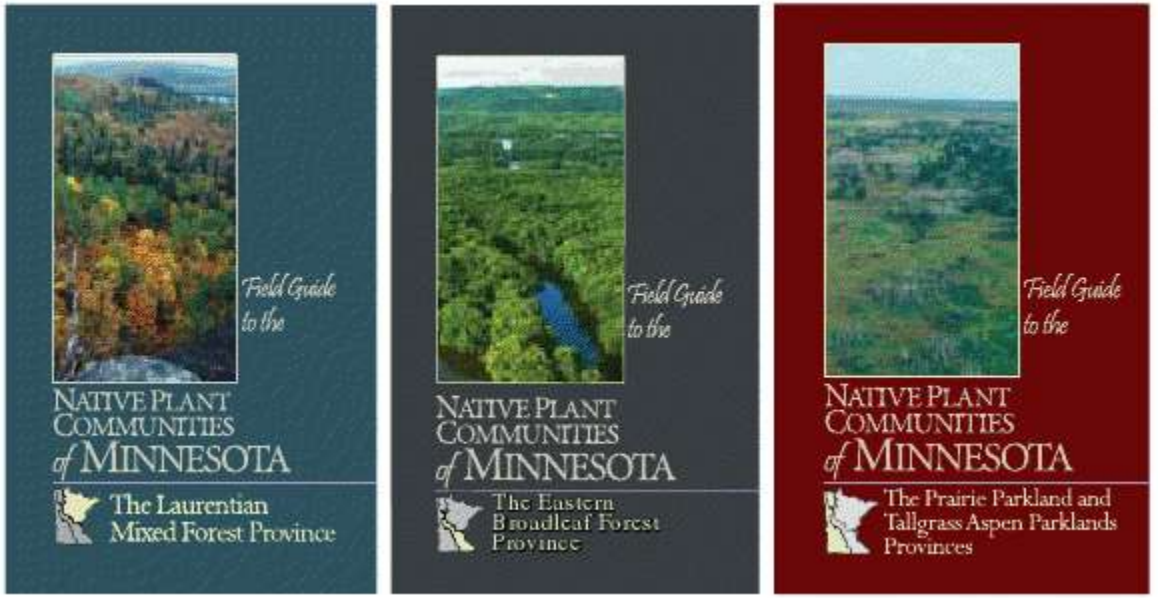
Spatial Modeling

- Use cluster analysis to identify unique combinations of soil, landform, climate for the Northern Superior Uplands
  - → Landscape Ecosystems
- Identify statistical associations between the Landscape Ecosystems and ~20000 Forest Inventory plots
  - → Electivity
- Use these relationships to map potential Landscape Ecosystems entire landscape
  - Landscape Ecosystems – term used for Native Plant Communities prior to development of formal classification
  - Potential – map covers all lands, including those currently in urban, agricultural or other land use


Landscape Ecosystem Classes
Northern Superior Uplands
Northern Hardwoods
Mesic white pine-red pine
Dry-mesic white pine-red pine
Mesic fir-spruce/aspen-birch
Dry mesic jack pine-black spruce
Jack pine-hardwood
Lowland Conifer
Rich swamp
Water
Non-forested wetland
Land Type Association Boundary
N
W
E
S
30
0
30
60
90 Miles

MN DNR Native Plant Community Classification (2003)

- NPC: "A group of native plants that interact with each other and their environment"
  - Form recognizable units that repeat over space and time
  - Classified considering vegetation, hydrology, landforms, soils and natural disturbance regimes



Native Plant Community has six hierarchical levels

Classification Level	Dominant Factors	Example
System Group	Vegetation structure & geology	Upland Forest & Woodland Systems
Ecological System	Ecological processes	Fire-Dependent Forest/Woodland
Floristic Region	Climate & paleohistory	Central
NPC Class	Local environmental conditions	Central Dry Pine Woodland
NPC Type	Canopy dominants, substrate, or finer environmental conditions	Jack Pine-(Yarrow) Woodland
NPC Subtype	Finer distinctions in canopy dominants, substrate, or environmental conditions	Ericaceous Shrub

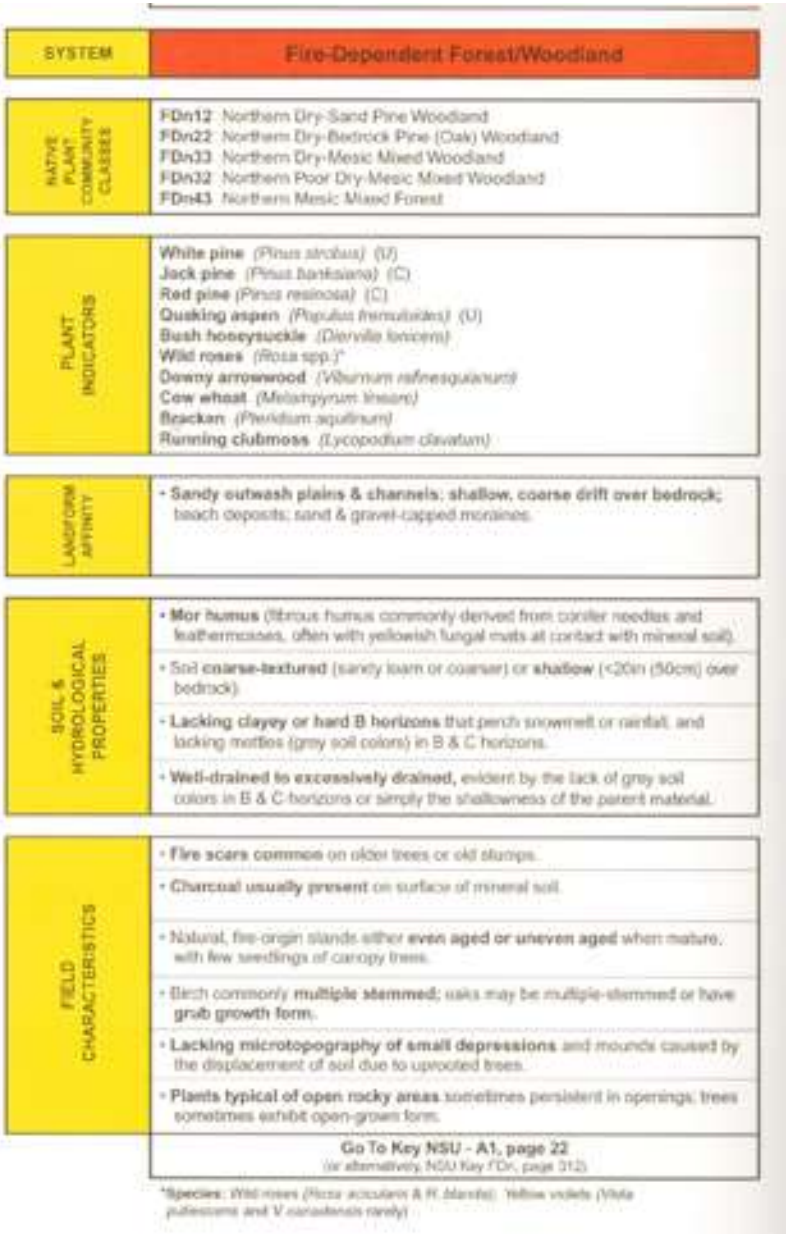
Group of NPCs unfied by a strong influence from major ecological processes

Uniform soil texture, moisture, topography, disturbance regimes

Dominant canopy trees,
Substrate, fine-scale differences in moisture and nutrients

NPC System level

- Defined by
  - Plant indicators
  - Landform affinity
  - Soil & hydrology
  - Field characteristics
- Useful for landscape (30,000 foot) planning

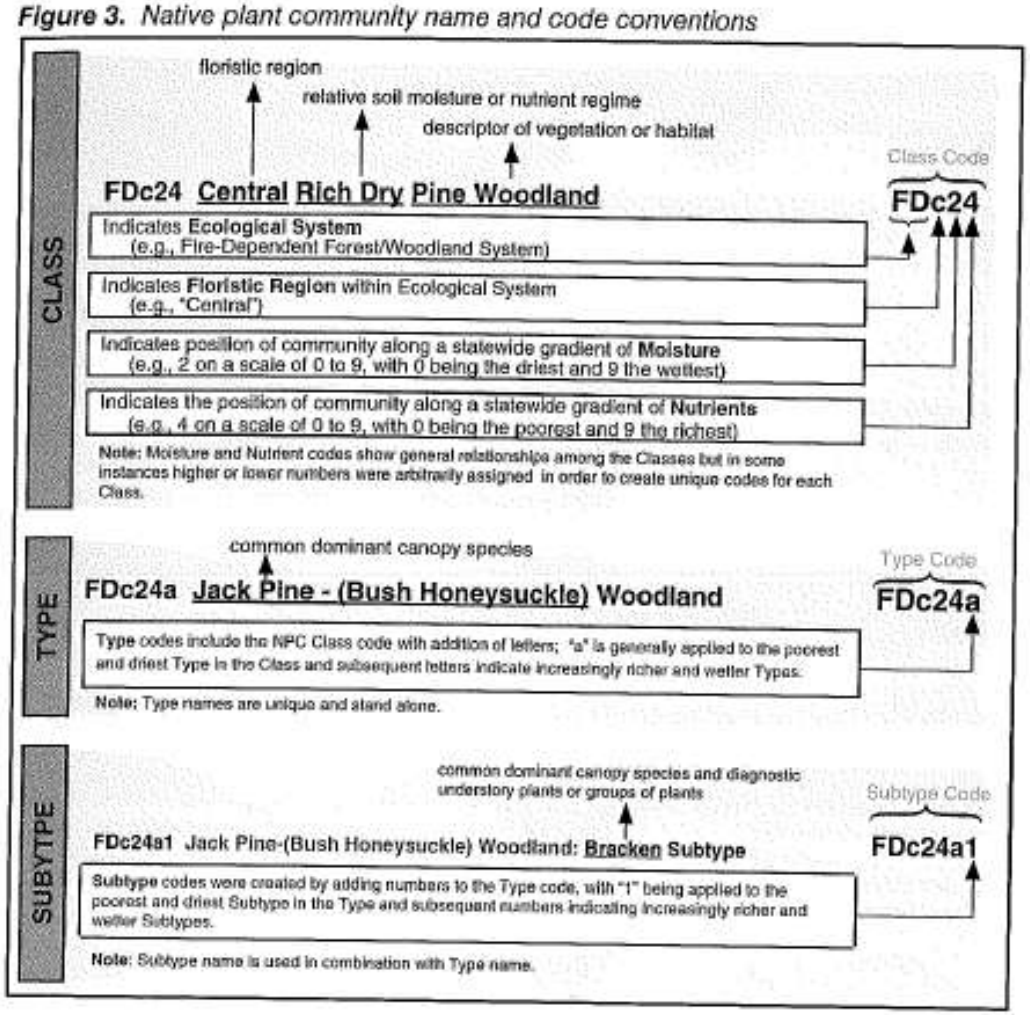


SYSTEM	Fire-Dependent Forest/Woodland
NATIVE PLANT COMMUNITY CLASSES	**FDn12** Northern Dry-Sand Pine Woodland **FDn22** Northern Dry-Bedrock Pine (Oak) Woodland **FDn33** Northern Dry-Mesic Mixed Woodland **FDn32** Northern Poor Dry-Mesic Mixed Woodland **FDn43** Northern Mesic Mixed Forest
PLANT INDICATORS	**White pine** *(Pinus strobus)* (U) **Jack pine** *(Pinus banksiana)* (C) **Red pine** *(Pinus resinosa)* (C) **Quaking aspen** *(Populus tremuloides)* (U) **Bush honeysuckle** *(Diervilla lonicera)* **Wild roses** *(Rosa spp.)** **Downy arrowwood** *(Viburnum rafinesquianum)* **Cow wheat** *(Melampyrum lineare)* **Bracken** *(Pteridium aquilinum)* **Running clubmoss** *(Lycopodium clavatum)*
LANDFORM AFFINITY	• **Sandy outwash plains & channels; shallow, coarse drift over bedrock;** beach deposits; sand & gravel-capped moraines.
SOIL & HYDROLOGICAL PROPERTIES	• **Mor humus** (fibrous humus commonly derived from conifer needles and feathermosses, often with yellowish fungal mats at contact with mineral soil). • Soil **coarse-textured** (sandy loam or coarser) or **shallow** (<20in (50cm) over bedrock). • **Lacking clayey or hard B horizons** that perch snowmelt or rainfall, and lacking mottles (gray soil colors) in B & C horizons. • **Well-drained to excessively drained,** evident by the lack of gray soil colors in B & C horizons or simply the shallowness of the parent material.
FIELD CHARACTERISTICS	• **Fire scars common** on older trees or old stumps. • **Charcoal usually present** on surface of mineral soil. • Natural, fire-origin stands either **even aged or uneven aged** when mature, with few seedlings of canopy trees. • Bark commonly **multiple stemmed;** oaks may be multiple-stemmed or have **grub growth form.** • **Lacking microtopography of small depressions** and mounds caused by the displacement of soil due to uprooted trees. • **Plants typical of open rocky areas** sometimes persistent in openings; trees sometimes exhibit open-grown form.
	Go To Key NSU - A1, page 22 *(or alternatively, NSU Key FDn, page 312)*

*Species: Wild roses *(Rosa acicularis & R. blanda)*; Yellow violets *(Viola pubescens and V. canadensis rarely)*

NPC Class level

- Defined by fine scale soil and moisture variables
- Higher resolution than System level
- Useful for local scale forest management planning



Landscape Ecosystems & Native Plant Communities

- Are they compatible?
  - Yes, with concerted group effort
- Mapping
  - same fundamental environmental data used in both systems
  - Map units of similar size to Minnesota-Ontario Peatlands effort
- Classification
  - Landscape Ecosystems roughly between System and Class level
  - Class-level assignments to LE map units can be made by incorporating GIS information or use of expert panels (or both!)

Current NPC efforts

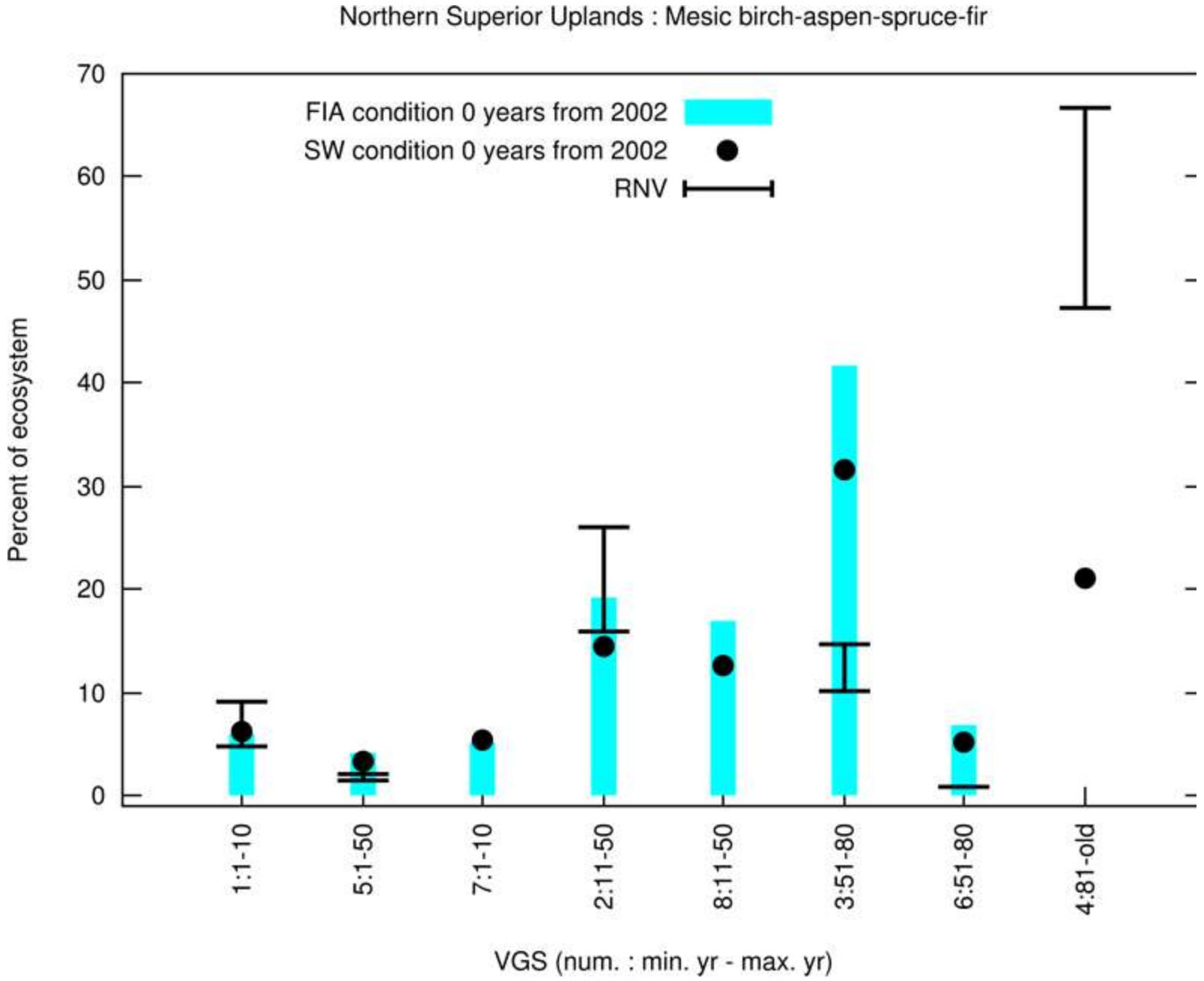
- The Drift and Lake Plains NPC map is at a coarser spatial resolution than the NSU or MOP
- Effort underway to map DLP and Western Superior Uplands with the same data sets and methods
  - Goal – a synoptic NPC map for the Laurentian Mixed Forest
    - Same spatial resolution
    - Same classification units

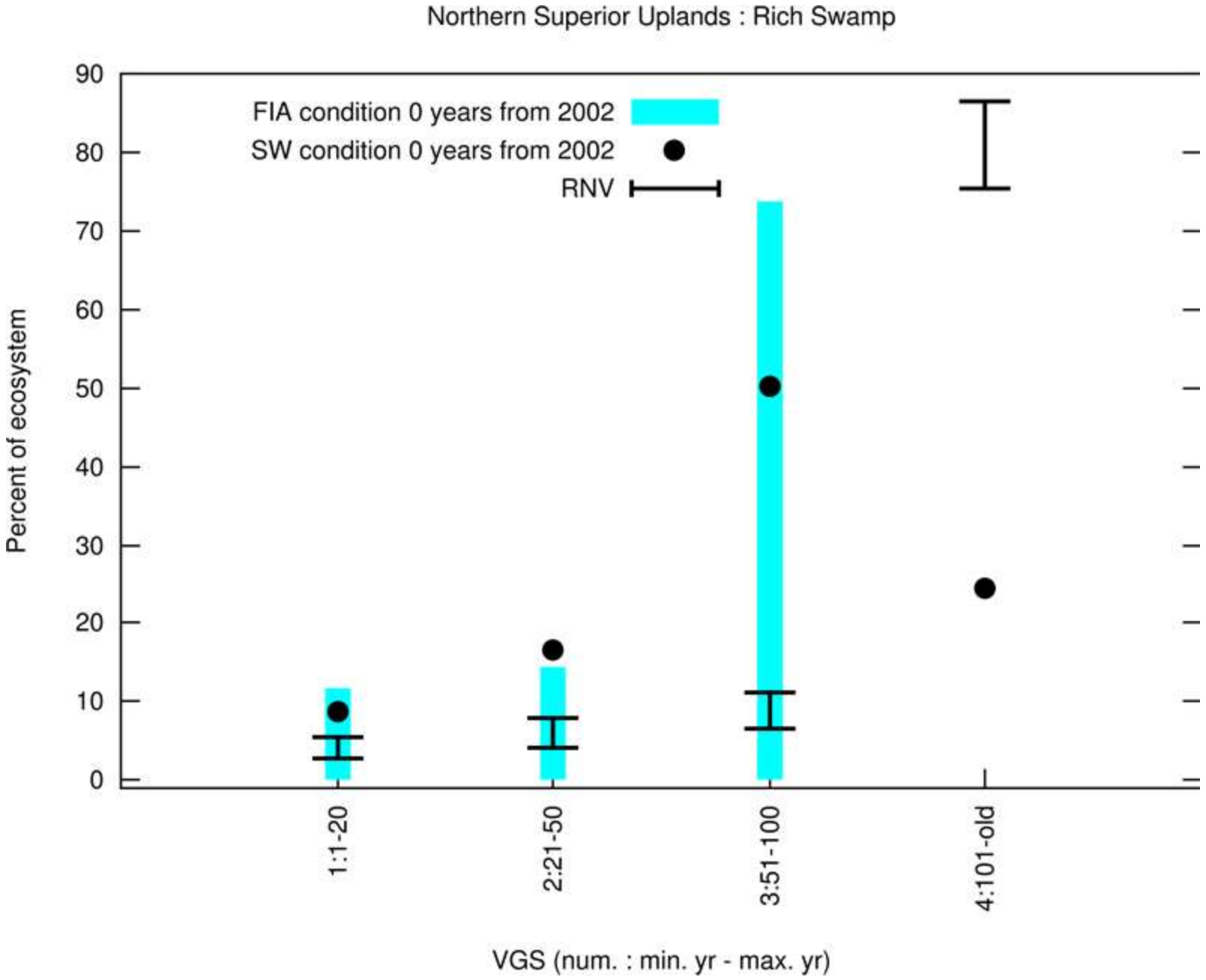
Questions & Comments?

Trends in Forest Composition & Spatial Pattern

Trends in Forest Composition

- 2006 – FRC (Dave Miller) requests a comparison of 1990 and 2002 forest inventory
- Which way are we heading?
- Conducted for DLP and NSU Sections


Northern Superior Uplands : Mesic birch-aspen-spruce-fir
FIA condition 0 years from 2002
SW condition 0 years from 2002
RNV
Percent of ecosystem
70
60
50
40
30
20
10
0
1:1-10
5:1-50
7:1-10
2:11-50
8:11-50
3:51-80
6:51-80
4:81-old
VGS (num. : min. yr - max. yr)

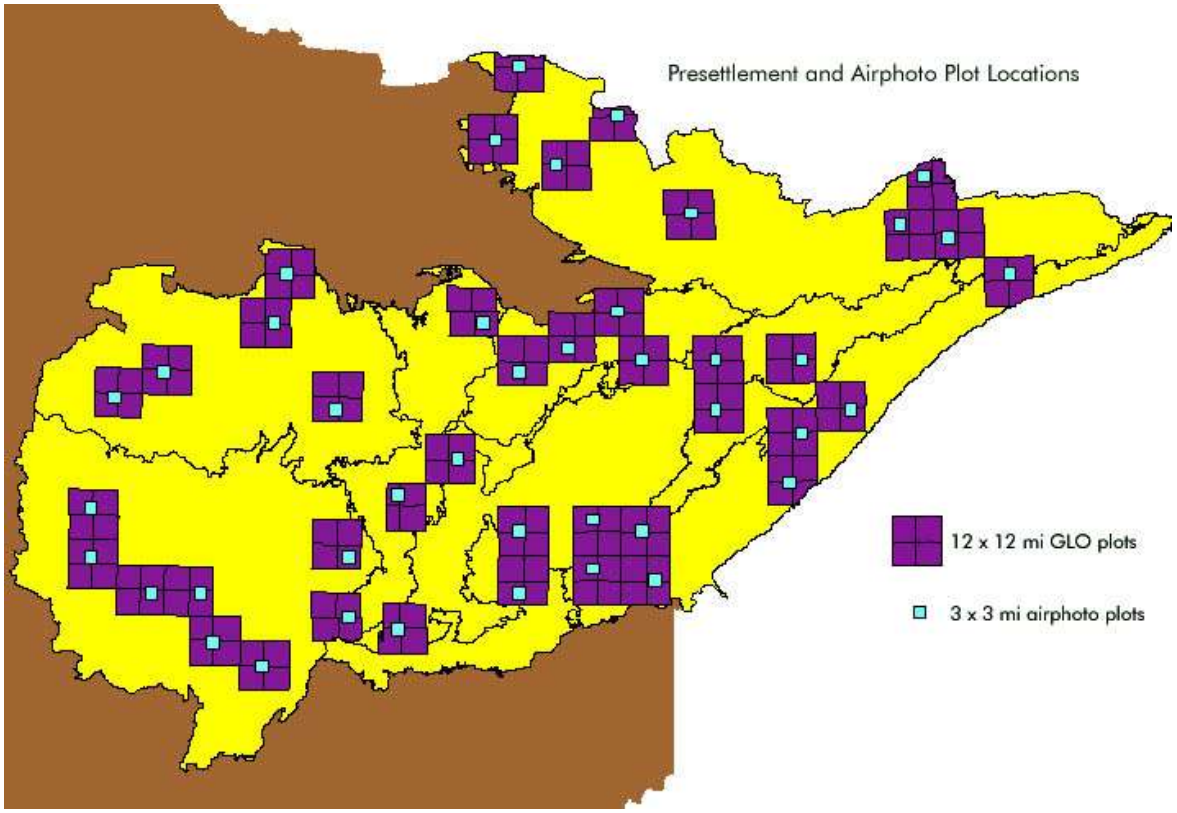

Northern Superior Uplands : Rich Swamp
FIA condition 0 years from 2002
SW condition 0 years from 2002
RNV
Percent of ecosystem
0
10
20
30
40
50
60
70
80
90
1:1-20
2:21-50
3:51-100
4:101-old
VGS (num. : min. yr - max. yr)

Update Highlights

- Many growth stages showed little change between the two inventories
  - 10 years relatively short time span
  - Smaller interval than most Vegetation Growth Stages
- Few FIA plots in old or multi-aged VGS categories
- FIA change of methods between 1990 -2003 confounds interpretation of data

Trends in Forest Disturbance

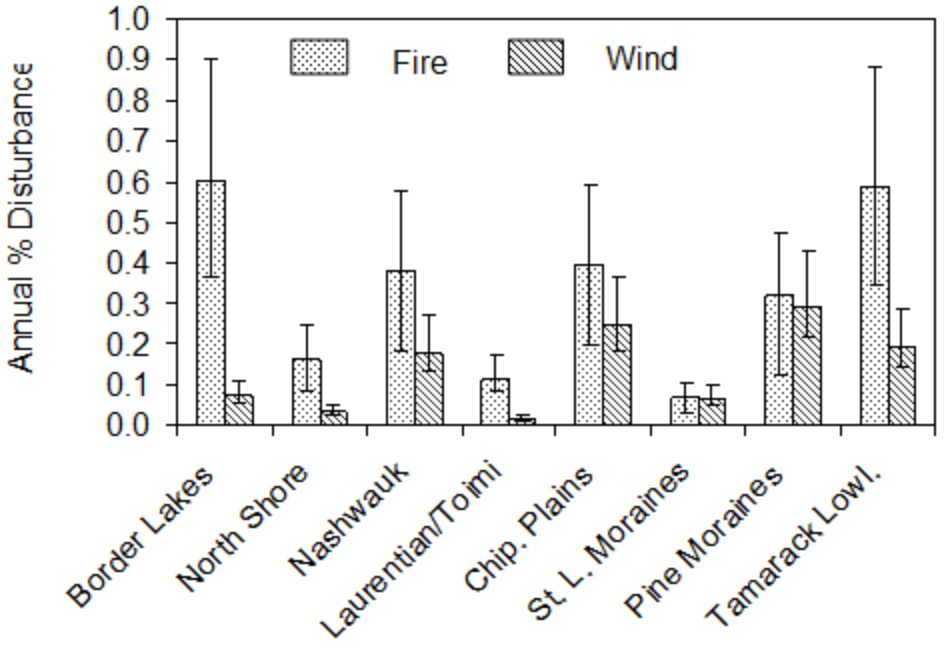
- Study
  - Quantify trends in disturbance frequency and size
  - Based on GLO survey and interpreted aerial photography from 1930s, 1970s 1990s
  - Covers 8 subsections in NSU and DLP



White, M.A. and G.E. Host. 2008. Forest disturbance frequency and patch structure from pre-European settlement to present in the Mixed Forest Province of Minnesota, USA. Can. J. of Forest Research 38:2212-2226.

Trends in Forest Disturbance

- Results
  - Fire was the dominant disturbance 1860 - 1890
  - 0.3-0.6% Annually
  - Border Lakes & Tamarack Lowlands highest frequencies
  - North Shore and Moraines low frequencies



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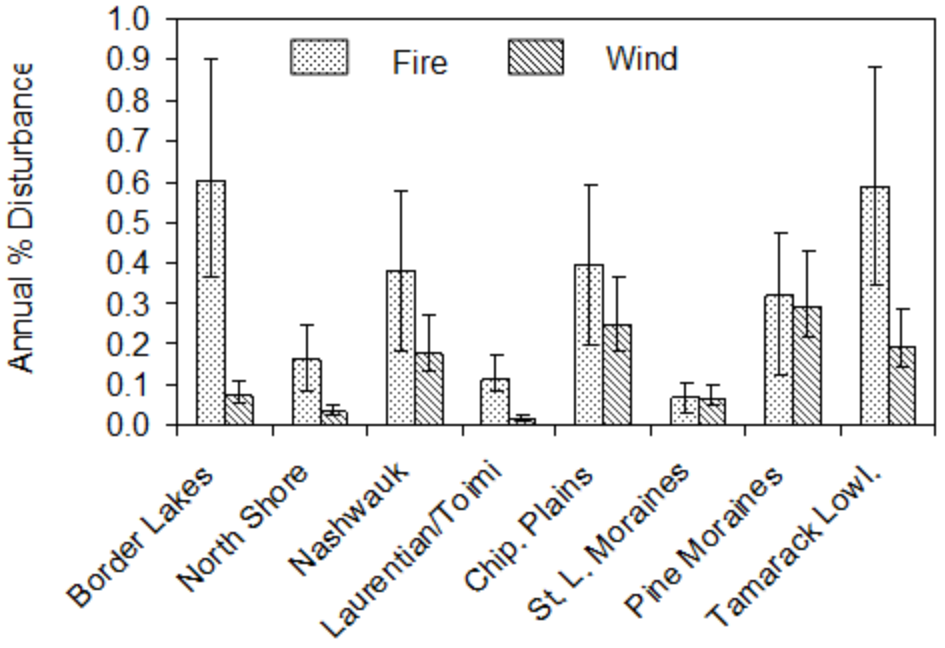

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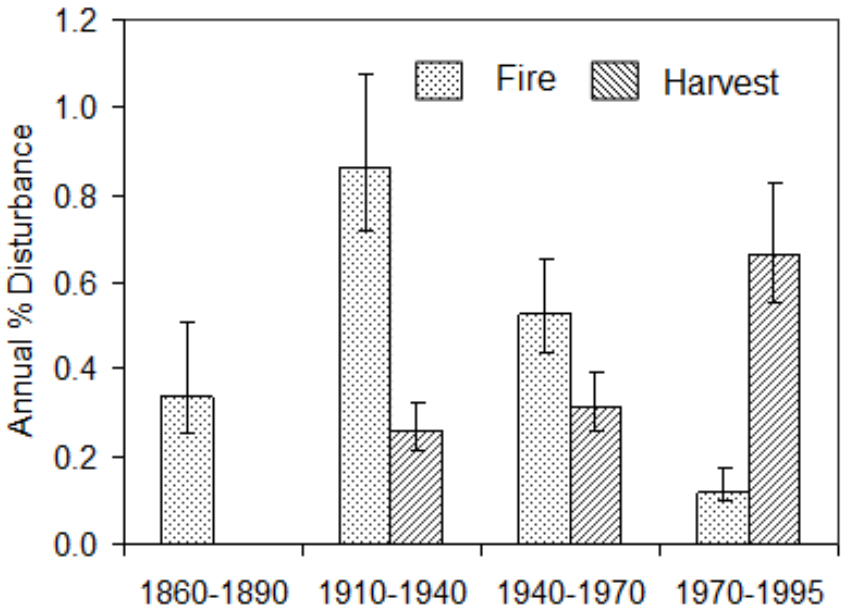
Trends in Forest Disturbance

- Results
  - Harvest has replaced fire as the dominant form of forest disturbance
  - 1910-1940
    - Large events in post settlement
  - 1970-1995
    - Even-aged management
    - Smaller and more uniform patch sizes
    - High edge density favors some wildlife species, reduces habitat for others



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Segue to Lindberg &
NLCD based change analysis

Applying Model Predictions to the Forest Landscape

- Run model at min and max estimates of disturbance frequencies to calculate the range of conditions (e.g. 10-20% of the ecosystem should be in pole size birch)